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Atty. Docket No. 8003-1016  
PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of  
Hiroshi YAMANE et al. Conf. No. 4564  
Serial No. 09/714,161 GROUP 1725  
Filed November 17, 2000 Examiner L. Tran  
METHOD AND APPARATUS FOR CONTINUOUS CASTING OF METALS

RESPONSE

Commissioner for Patents  
Washington, D.C. 20231

September 23, 2002

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Sir:

This replies to the Official Action of May 23, 2002.

Claims 1-6, 9, 10, 17 and 19 are pending in this application.

This application has been refilled as a Request for Continued Examination (RCE) in order to bring to the attention of the Examiner three Japanese references that may be of interest. These are JP 9-262650 and JP 9-262651 (hereinafter called Miyazawa) and JP 10-305353 (hereinafter called Murakami).

In Murakami, a magnetic field comprising a superposed DC static magnetic field and an AC shifting or moving magnetic field, were applied to the mold and molten metal therein.

Murakami does not deal with the type of shifting field, but discloses only that it results in horizontally circulating macro flow, as in Figure 4 in our application, and does not suggest a shifting field in a longitudinally symmetrical relation, nor discloses the problem of circulation flow.

In Miyazawa, a moving magnetic field and a static magnetic field are alternatively applied to molten metal. Only circulating macro flow is disclosed as the moving field.

As to Fujisaki et al., previously applied, it is not to be expected that the system of applicants' invention needs only low voltage, such that a single phase would be more effective and applicable.

Actually, as to our Figures 2 and 4, the alignment of the electromagnets as shown in our Fig. 2 requires more electric power for moving the same volume of molten bath than in the case with the alignment shown in Figure 4. This is because, when the phase contrast between adjacent electromagnets is around  $180^\circ$ , a great deal of magnetic flux does not penetrate the molten bath, but flows by taking a shorter route to adjacent electromagnets, and the amount of magnetic flux penetrating the molten bath decreases as compared with the case wherein electro magnets, to which an AC current of two phases or more, is supplied, are disposed (see the attached figures from our drawings, showing Figs. 2 and 4.

As a result, in view of the efficiency of electric power consumption, a single phase AC current is inferior to two phase or three phase AC currents. But for achieving the metallurgical effects, namely, improvement of slab quality as in the present invention, rather than suppressing the macro flow of the molten metal as conventionally preferred, a molten metal flow of short range is achieved, and for effecting this, arrangements in a

predetermined alignment of the phases of coils and the use of a single phase source is used.

Thus, because single phase AC is less power effective than two or three phase, its use in the present invention is unobvious.

Attached hereto is a Reference Table, in two sheets, which compare the present invention to a conventional technique as shown, for example, in FUJISAKI et al. As will be seen from FUJISAKI et al., in that reference there are taught a number of embodiments of arrangement of electromagnets, in which the magnetic field is applied to molten metal (see C to E in the attached Reference Table, for example). However, each such arrangement is made for creating a macroscopic flow of molten metal in the mold, according to the conventional technique (A in the Reference Table). FUJISAKI et al. teach dividing a row of electromagnets into several blocks, so as to achieve more uniform macroscopic flow.

Macroscopic flow of molten metal is favorable to the extent that molten metal is stirred, so as to avoid segregation or capture of inclusions. However, as the macroscopic flow of molten metal exists in a substantial area in the mold, it is hard to avoid local vortices or stagnation, and defects result in the cast slab by inclusion of the resulting entrainment of flux.

By contrast, in the present invention, electromagnets are arranged so as to create non-moving but vibrating fields. This is quite different from conventional practices such as those

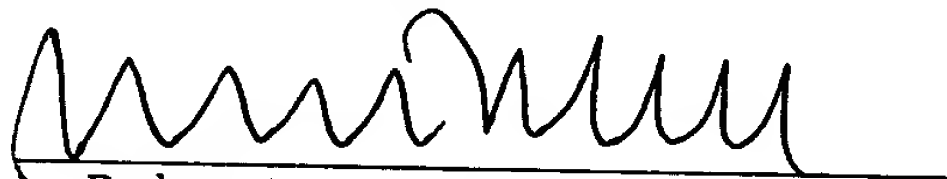
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of FUJISAKI et al., and results in the new and improved results pointed out in our specification.

In view of the foregoing, therefore, it is believed that this application is in condition for allowance, and passeth to issue at the time of the first official action is respectfully requested.

Respectfully submitted,

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Enclosures